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THE GEOLOGY OF THE CLOGHER—SLIEVE BEAGH AREA, COUNTY TYRONE.

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THE GEOLOGY OF THE CLOGHER-SLIEVE BEAGH AREA, CO. TYRONE.

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1. Introduction.

The area under consideration is situated in the south part of County Tyrone, Northern Ireland, and covers about 35 square miles. It includes a portion of the Clogher Valley and ground to the south of it, culminating in the elongated hump of Slieve Beagh (1,221 feet)—a mountain of no great topographical distinction. The upper courses of southward-flowing streams provide valuable information about the stratigraphy and structure of the region. Lower down, however, the heavy cover of drift and alluvium seriously interrupts the lateral and vertical continuity of the exposures. See Map, fig 4.

The first geological work in the area was confined to a description of the lithological types with a map of their distribution (Portlock, 1843). Many fossils were collected, some being figured and described, but localisation of the material is usually very poor. This was followed by the official geological survey, the results of which are embodied in a memoir to the appropriate sheet (Cruise, 1887) and include :—

1. The detailed mapping of the lithological divisions in the Carboniferous rocks Millstone Grit, Yoredale Beds, Upper, Mid, and Lower Limestones, and Lower Carboniferous Sandstone and Shale ;
2. the collection and naming of a few fossils whose localities are accurately recorded ;
3. the recognition of an important fault disturbance trending in a north-east to south-west direction.

No further field work was carried out until the author entered the area, but a few fossils from the area are mentioned in palaeontological literature. These include *Tropidocyclus oldhami* (Portlock), described by Weir (1931, p. 838), and *Beyrichoceras mutabile* (Phill.), recorded from the ' Fury River ' by Bisat (1934, p. 287). In the present paper the results of an investigation into the faunal stratigraphy and structure of the beds are given.

During the course of the work, various people have helped in the identification of the fossil material, and I take this opportunity of thanking them for their assistance. Dr. Muir-Wood, who commented on some brachiopods submitted to her, Dr. S. Smith, who identified a syringoporoid coral, Dr. K. P. Oakley, who examined a few Bryozoans, and Dr. C. J. Stubblefield, who offered help and criticism of the fossils in

general. To Mr. W. S. Bisat the author is deeply grateful for his identification of the goniatites, while to Mr. J. S. Turner a special debt of gratitude is due for his constant help in many ways. To Professor J. K. Charlesworth the author owes much for his interest and encouragement throughout the progress of the work, and for the facilities made available at Queen's University, Belfast. Finally, a grant from the research fund of the latter institution is gratefully acknowledged.

2. The Stratigraphical Succession.

The stratigraphical succession of beds in the area is as follows :—

(vi)	Millstone Grit ...		100 feet +	?
(v)	Yoredale Beds	Unfossiliferous	300–350 feet	?P.
		Fossiliferous	350–400 feet	B_2P_1
(iv)	Upper Limestone	Upper Division	400 feet	D
		Lower Division	1,300 feet	S_2D_1
(iii)	Calp Sandstone		250 feet	S
(ii)	Lower Limestone	(at Fardross)	100 feet +	C_2S_1
(ii)	Lower Carboniferous Sandstone and Shale	Belelastera Shales	170 feet	$?C_2S_1$
		Mullan's Burn	35–40 feet	$?C_2S_1$
(i)	Old Red Sandstone			

(*i*) *The Old Red Sandstone.*

In the extreme north-west, part of the main Old Red outcrop of Tyrone and Fermanagh is present. It consists of red sandstones, grits, and occasional conglomerates faulted against the Lower Carboniferous strata of the Clogher Valley. A further outcrop of the formation is deduced from a few exposures of red, conglomeratic sandstone to the south and east of Augher. These occur in Mullan's Burn and Altnaveagh Glen, while the soils in the vicinity are reddish. On this evidence the margin of the Old Red outcrop is placed further to the south-east than is shown on the Geological Survey map. Extensive spreads of drift, however, make the accurate determination of the limits of the formation impossible.

Unfortunately, no palaeontological evidence is forthcoming to differentiate Old Red Sandstone conglomerates and sandstones from basal Carboniferous beds. The age of the Old Red Sandstone itself is also unknown, though a clue is provided by

the find of a *Pteraspis* which proves a Lower Old Red Sandstone age for beds in the region of Lisbellaw (Harper and Hartley, 1938). Since the small area near Augher appears to be an inlier of the Lisbellaw mass faulted up, it may also, if doubtfully, be ascribed to this age.

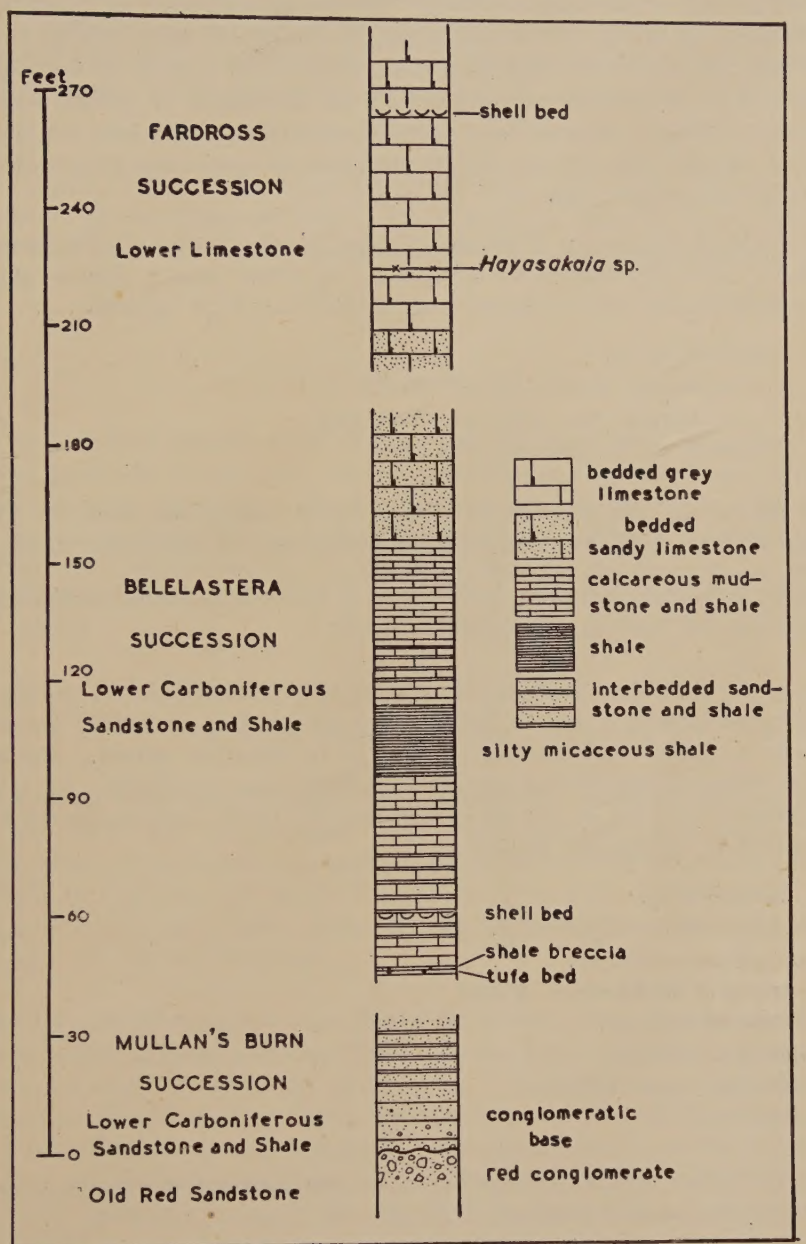

FIG. 1.—*Vertical successions of ? Lower Viséan beds exposed in the Clogher–Slieve Beagh area.*

(ii) Lower Carboniferous Sandstone and Shale and Lower Limestone, : ?Lower Viséan, C_2S_1 (fig. 1).

Lower Carboniferous Sandstone and Shale and Lower Limestone outcrop over the lower ground of the Clogher Valley. The former is exposed in Mullan's Burn, where between 35 and 40 feet of conglomerates and pebbly grits, usually cemented with calcite, rest on the Old Red Sandstone. These basal beds of the Carboniferous formation show on petrological examination an abundance of quartz with small quantities of feldspar. Fragments of perthite, microcline, plagioclase, and quartzite also occur. Higher beds consist of more even-grained sandstones interbedded with fossiliferous micaceous shales.

In the Fury River, near Belelastera Bridge, about 170 feet of silty limestones, silty shales, and silty calcareous mudstones are folded into a shallow anticline. A few lamellibranchs were collected from a shell bed (F9)* including :—

Parallelodon sp.
Protoschizodus axiniformis (Portlock)
P. axiniformis var. *depressus* (Portlock)
Schizodus cf. *axiniformis* (Phillips)

It is of interest to note that Portlock recorded *P. axiniformis* from the Clogher area, and it seems likely that his material came from the Belelastera Shales also.

Similar beds occur elsewhere in the area, at Daisy Hill, Solomon's Bridge, and Waring Bank, but have as yet yielded no fossils.

The Lower Limestone is exposed at a number of scattered places, but the most satisfactory succession occurs at Fardross, where 100 feet of bedded limestones, folded into a shallow anticline, are exposed in an unnamed stream. The lowest strata are distinctly arenaceous, and have yielded a few spiriferids. At a higher horizon, a shell bed, rich in individuals but poor in species, outcrops in the bed of the stream (F.D. 5) and has yielded :—

Fenestella sp.
Athyris planosulcata Phill.
? *Camarotoechia* sp.
Chonetes papilionacea (Phill.)
Schellwienella sp.
Dictyoclostus sp.
Pustula rugata (Phill.)
Spiriferid.

About 40 feet below the shell bed and in the same stream section, the syringoporoid coral *Hayasakaia* sp. was collected (F.D. 4).

* Denotes a fossil locality. See pp. 80-81

The transgression of the Carboniferous seas into the area, then, appears to have been fairly rapid over a terrain with much debris already loosened by sub-aerial erosion. Much of this material, in pebbly form, was incorporated in the local basal conglomerates. It represents largely reworked Old Red Sandstone. The nature of the beds immediately succeeding suggests the persistence of land undergoing erosion in the near vicinity, creating a muddy marine environment unsuitable for benthonic life. Fairly shallow waters with some contemporaneous erosion are suggested by the presence of a shale breccia horizon in the Belelastera Shales. The limestones at Fardross represent the clearing of the sea, and the invasion by a richer marine fauna.

The paucity of the fossils, especially in the basal beds, renders the date of the Carboniferous transgression uncertain. Since, however, they are quite distinct in lithology from the thick S_2D limestone series above, a Lower Viséan age is tentatively suggested.

(*iii*) *The Calp Sandstone: S.*

In an unnamed stream south of Fardross, steeply inclined beds of massive, micaceous sandstone are exposed. These constitute the Calp Sandstone of the Mid Limestone division of the Survey Memoir, and are about 250 feet thick. They appear to be faulted to the north-west against Lower Viséan strata. Towards the top, a few thin, interbedded, crinoidal shales are present, but the transition to the succeeding Mid Viséan limestone is fairly abrupt. No fossils were found except a little crinoid debris.

(*iv*) *Upper Limestone: Mid Viséan, S_2D.*

The Upper Limestone emerges from beneath the Yoredale Beds at various places, notably in the Fymore region, near Lough More, and in the upper part of the Fury River. Faulted junctions against younger strata were observed at Slatmore (south-west of Fardross) and in the lower part of the Fury River. In all, about 1,700 feet of bedded limestones are present, and these may be conveniently divided into Upper and Lower Divisions.

The lower division includes 1,300 feet of well-bedded, grey, crystalline limestones with interbedded calcareous shales. The latter are often somewhat micaceous but contain a rich fauna of corals and brachiopods. The fossils are usually flattened to some extent, but those from the harder limestone strata are relatively uncrushed. Beds of this division are well exposed in the unnamed stream south of Fardross, where they are seen to overlie the Calp Sandstone and can be followed almost continuously upstream for more than $\frac{1}{4}$ mile. Further to the north-east similar

beds are exposed in a small quarry (F2″) and in the Fury River (F14), where the beds are sharply folded, and again in a small quarry at Fymore (13). Fossils from beds of this division include the following :—

Fenestella spp. 11, 13, 33x.
F. aff. *flustriformis* Phill. 33x.
F. irregularis (Phill.) 11.
F. varicosa (M'Coy) 33x.
Polypora papillata M'Coy 11.
Batostomella sp. F2″.
Tabulipora sp. F2″.
Caninia spp. F2″, 11, 13, 33x, 39.
C. benburbensis Lewis F2″, 13, 33x, 39.
Clisiophyllid *Lithostrotion* (cf. Douglas, 1909, p. 581) 13, F2″.
Clisiophyllum sp., 39.
C. curkeenense Vaughan F14, 13. F2″.
C. nemistioides ? Lewis F2″, F14.
Dibunophyllum sp. F2″.
Lithostrotion affine Ed. & H. F14, 39.
L. cf. *affine* Ed. & H. 33x.
L. cf. *aranea* Ed. & H. F14, 33x.
L. irregulare Auctt. 13, F14, 33x.
L. martini Ed. & H. var. *densum* Lewis F2″.
L. pauciradiale (M'Coy) F14, 33x.
L. phillipsi Ed. & H. F2″, F14, 33x, 39.
L. aff. *scoticum* Hill. F14.
Syringopora ramulosa Goldf. 33x.
S. cf. *reticulata* Goldf. 39.
Tryplophyllites enniskilleni (Ed. and H.)
Zaphrentites delanouei (Ed. and H.) 11.
Z. cf. *lawstonensis* (Carr.) F2″, 13, 33x.
Euomphalus sp. 39.
Athyris planosulcata Phill. 11, F14.
Camarotoechia sp. 11.
C. pleurodon (Phill.) 11.
Chonetes laguessianus de Kon. 11.
Derbyia sp. F14.
Dictyoclostus spp. 11, F14, 33x.
D. cf. *hindi* Muir-Wood 11.
D. cf. *insculptus* Muir-Wood 33x.
Echinoconchus sp. 11.
E. defensus? (I. Thomas). 13.
E. elegans (M'Coy) 11.
Gigantoproductus spp. F2″, F14, 13, 33x, 39.
G. aff. *maximus* (M'Coy) 13.

G. cf. *maximus* (M'Coy) 13.
Leptaena analoga (Phill.) 11, 13.
Linoproductus sp. 13.
Orthotetid 11.
Overtonia fimbriata (J. de C. Sow.) 11, F14.
Phricodothyris sp. 11.
Productina margaritacea (Phill.) 11, 13.
Punctospirifer sp. 33x.
Pustula sp. 11.
P. aff. *pilosa* I. Thomas F2″, 11.
P. pyxidiformis (de Kon.) F2″, 11.
Reticularia sp. 11.
R. aff. *obtusa* (J. Sow.) 11.
Rhipidomella michelini (L'Eveille) 33x.
Schuchertella radialis (Phill.) Dav. F2″.
Spirifer bisulcatus J. de C. Sow. 11.
S. spp. 11, F14, 33x.
Tylothyris laminosa (M'Coy) cf. mut. *β* North F14.
T. laminosa (M'Coy) 33x.
Phillipsia sp. 11.

Mention must be made of a purer and more thickly bedded limestone which resembles the Great Scar Limestone of Yorkshire in appearance. Exposures occur in a small quarry at Crocknanore (F2′) near the Fury River and at ' Kilruddan Rock ' (9) a short distance to the east. A thickness up to 40 feet is visible in both outcrops, but the relationship to other beds in the succession remains obscure. No normal junctions can be seen, and mapping suggests the exposures are bounded by faults, one of which is clearly seen in the entrance to Crocknanore Quarry. This conclusion is further supported by the intense brecciation which the beds have suffered, with associated calcite veining. Similar limestone, but without the brecciated appearance and veining, outcrops at Carrickevin (46) near Slatmore. Here it forms part of the Upper Limestone succession, which is dipping at about 45 degrees to the north-west, and appears to lie near the top of the lower division. It is suggested that the limestones at Crocknanore and Kilruddan Rock also belong to this part of the succession.

Fossils were fairly plentiful and the following were identified :—

Fenestella spp. 9.
Allotropiophyllum cf. *tuberculatum* (Thomson) F2′.
Caninia spp. 9, 46.
C. benburbensis Lewis 9, 46.
Clisiophyllum sp. (cf. Lewis, 1930, p. 269) 9.
Dibunophyllum sp. 9.
Fasciculophyllum densum (Carruthers) F2′.

Koninckophyllum sp. 46.
Lithostrotion irregulare Auctt. 9.
L. phillipsi Ed. & H. 46.
L. aff. *scoticum* Hill. 9.
Rotiphyllum sp. F2′.
Rylstonia sp. F2′.
Syringopora ramulosa Goldf. 9, 46.
S. cf. *reticulata* Goldf. 9, 46.
Brachythyris sp. 46.
B. integricosta (Phill.) F2′.
Chonetes laguessianus de Kon. 9.
Crurithyris sp. F2′.
Dictyoclostus sp. 9.
Echinoconchus elegans? (M'Coy) 9.
E. venustus (I. Thomas) 9.
Gigantoproductus sp. 9.
Krotovia spinulosa (Martin) 9.
Linoproductus undatus (Defr.) 9.
L. sp. 9.
Orthotetid 9.
Rhipidomella michelini L'Eveille 9.
Spirifer bisulcatus J. de C. Sow. 9, F2′.
Spiriferid F2′.
Bradyodont tooth F2′.

The remaining 400 feet of the Upper Limestone belong to the upper division and can be most conveniently followed in the upper course of the Fury River. Elsewhere exposures are less continuous, but the conformable relationship to the overlying Yoredale Beds is never in doubt. The limestones of this division are similar to those below, except for a higher content of iron oxide which forms a distinctive brown crust on weathered surfaces. The highest beds have detrital impurities in the form of silt and sand, which herald the conditions of the Yoredale series, and bring the open sea limestone phase to a close.

In addition to this lithological difference, the upper division differs from the lower in its fauna, which is much less abundant, and in its species : corals of the *Caninia-Clisiophyllum-Lithostrotion* association are replaced by cyathaxonid forms, and many of the productids of the lower division are absent altogether. The fauna present includes the following :—

Fenestella cf. *morrissi* M'Coy 33.
F. polyporata (Phill.) 70.
F. sp. 70.
Cyathaxonia rushiana Vaughan 33, 70.
Fasciculophyllum omaliusi (Ed. & H. 70.
Michelinia aff. *tenuisepta* (Phill.) 70.

Rhopalolasma bradbournensis (Wilmore) 33, 70.
R. aff. *bradbournensis* (Wilmore) 70.
R. sp. 33.
Rylstonia benecompacta Hudson and Platt 33.
Zaphrentites delanouei (Ed. and H.) 33.
Brachythyris integricosta (Phill.) 33.
Chonetes hardrensis Phill. 33.
C. cf. *laguessianus* de Kon. 33.
Eomarginifera sp. 33.
Lingula sp. 33.
L. squamiformis Phill. 70.
Orthotetid 33.
Spirifer bisulcatus J. de C. Sow. 33.
S. sp. 33.
Murchisonia sp. 33.
'Orthoceras' sp. 70.
?Nautiloid : species indet. 70.

The assignment to the Mid-Viséan of all the limestone of the upper and lower divisions is largely based on the corals and brachiopods. Of the former, *Lithostrotion phillipsi*, *L. irregulare*, and *L. aranea* are quite common in the lower division, and appear to be the local Irish equivalents of similar corals present in the Mid-Viséan elsewhere, e.g. *L. scoticum* from Kircudbrightshire, *L. pauciradiale* from County Sligo, and *L.* (*Nematophyllum*) *minus* from the North-West Province. Among the solitary forms, the Clisiophyllids can be fairly closely matched with similar forms recorded from the Mid-Viséan by various authors, viz. Clisiophyllid *Lithostrotion* (Vaughan, 1905, Pl. XXIII, fig. 5, p. 277 and Douglas, 1909, Pl. XXVII, fig. 3, p. 581), *Clisiophyllum nemistioides* (Lewis, 1930, Pl. XXII, figs. 7a–7d, p. 268) and *Clisiophyllum curkeenense* (Vaughan, 1906, Pl. XXX, figs. 2–2a, p. 320). Some of these forms have a prominent, flat, median plate strongly reminiscent of the young stage in the genus *Dibunophyllum*. Among the Caninids, *C. benburbensis* and undescribed forms similar to it are particularly abundant. *C. benburbensis* itself is a fairly reliable index fossil elsewhere in Britain, where it denotes a Mid-Viséan age though the horizon of the holotype is uncertain.

Of the brachiopods, an undescribed group of Gigantoproductids akin to *Productus* (*Gigantoproductus*) *maximus*, is present. Professor G. Delépine expressed an opinion that such forms would be typical of D_1 in Belgium.

The fauna of the upper division is admittedly a facies fauna, and indicates a deterioration of environment for benthonic life. Most of the species recorded, however, such as *Rhopalolasma bradbournensis* are known from the Mid-Viséan elsewhere (Yorkshire, for example), and there is nothing to prove that the upper division ranges higher than D_1.

(v) *Yoredale Beds; Cracoean and Lower Bollandian, B_2P_1.*

The Yoredale Beds, about 750 feet in thickness, include shales, often fossiliferous, siltstones, sandstones, a few thin impure limestones, and calcareous mudstones. They show a tendency towards rapid variation in thickness, but the whole series constitutes a conformable succession without any trace of eroded surfaces or any angular discordance of beds.

The most satisfactory and continuous section of the Yoredale Beds occurs in the Fury River. Here the lowermost 350 to 400 feet of strata consist of sandstones and fossiliferous shales, beginning with a sandstone 90 feet thick which rests directly on the Upper Limestone. Some of the basal beds are somewhat calcareous, but

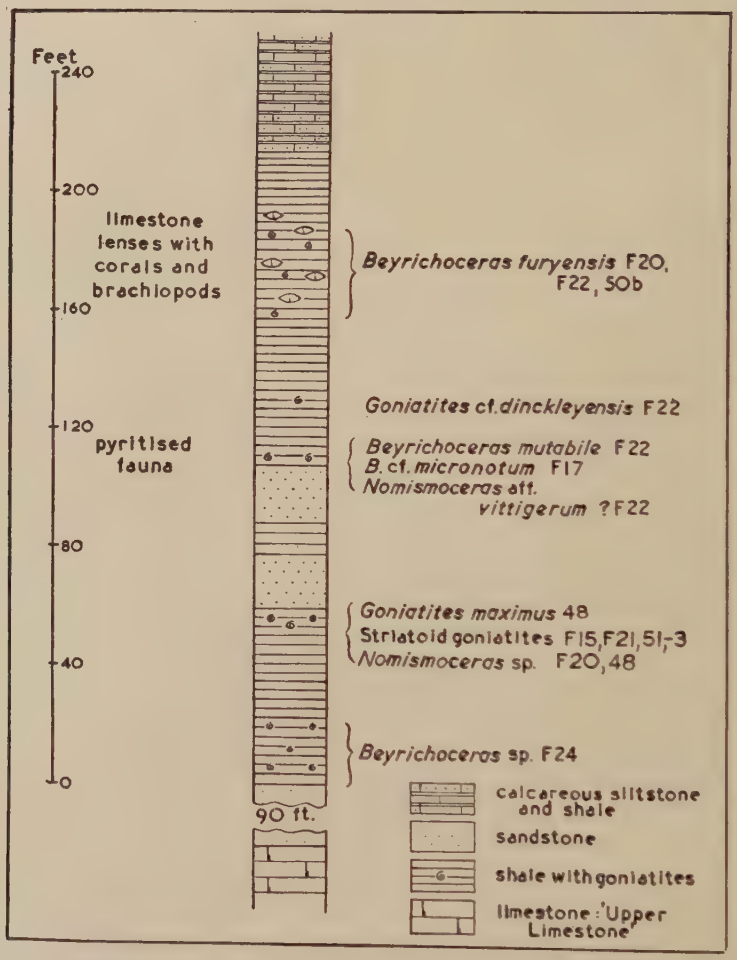

FIG 2.—*Vertical section of the fossiliferous portion of the Yoredale Beds. Five goniatite horizons are shown, and those numbers prefixed by the letter F refer to fossil localities in the Fury River.*

the main body of the sandstone is massive and well jointed. It forms a distinct topographical feature, and is well exposed in a gorge cut by the Fury River. The change in lithology from the Mid-Viséan limestones to the sandstones and shales of the Yoredale Beds is accompanied by a change in the fauna. Goniatites, lamellibranchs, and gastropods are particularly abundant in the lower shales of the Yoredale Beds, and five goniatite horizons are recognizable (fig. 2). These indicate a range from the *Beyrichoceras* (B_2) subzone to the succeeding *Posidonia* (P_1) subzone. The details of the faunal horizons given below include information not only from the Fury River section but also from exposures elsewhere in the area.

Beyrichoceras Zone, B_2.

(*a*) *Beyrichoceras* sp. horizon. Numerous flattened specimens of *Beyrichoceras* sp. were collected from grey calcareous shales immediately above the thick, massively bedded and unfossiliferous sandstone at the base of the Yoredale Beds in the Fury River (F24). The following were also found :—

Martinia aff. *glabra* (J. Sow.)
Aviculopecten sp.
Nuculopsis gibbosus (Flem.)
Nuculana attenuata (Flem.)
Glabrocingulum cf. *armstrongi* E. G. Thomas.

A collection of goniatites from the Fury River, handed to me by Mr. J. S. Turner, included a single specimen of *Muensteroceras* sp. The actual locality is unknown, but it may have come from this, the lowest goniatite horizon in the area.

(*b*) *Goniatites maximus* horizon. In a small and much overgrown stream on the west side of McGregor's Hill (48) the following section is exposed :—

ft.	ins.	
3	0	Sandstone
35–40		Shaley mudstone with harder bands of calcareous mudstone. Shales with ironstone nodules. Goniatite-bearing shales.
	7	Pale grey limestone.
4	0	Calcareous mudstone.
4	0	Bedded sandstone.
16	6	Greenish-grey shales.
7	0	Pale grey limestone.
3	6	Greenish-grey shales occasionally reddish.
10	0	Grey limestone interbedded with grey, calcareous shale.

In the goniatite material from the lower part of the 35–40 feet of shale *Goniatites maximus* Bisat was identified : also a number of striatoid fragments

with spiral ornament and a single specimen showing a crenistriate pattern. The following were also collected :—

Edmondia aff. *transversa* Hind.
Nuculopsis gibbosus (Flem.)
N. aff. *gibbosus* (Flem.)
Palaeoneilo aff. *laevirostris* (Portl.)
Parallelodon tenuistria (M'Coy)
Bucaniopsis hibernicus Weir.
Glabrocingulum sp.
Trepospira sp.
Tropidocyclus oldhami (Portl.)
'Orthoceras' sp.
Stroboceras ? sp.
Nomismoceras sp.

In the Fury River, some fossiliferous, calcareous shales yielded a number of fragments of striatoid goniatites and one with a crenistriate pattern (F20/21). The associated fauna is as follows :—

Fasciculophyllum aff. *omaliusi* (Ed. & H.)
Dunbarella sp.
Nucula cf. *aequalis* J. Sow.
N. aff. *luciniformis* Phill.
Posidoniella sp.
Bucaniopsis hibernicus Weir.
Euomphalus sp.
Orthocone Nautiloids
Cyrtocone Nautiloids (cf. *Cyrtoceras tuberculatum* M'Coy).
Thrincoceras? sp.
Phillipsia? sp. (pygidium only).

No undoubted specimen of *G. maximus* was found, but this horizon with striatoids in the Fury River may very well be the same as that on McGregor's Hill. Unfortunately, faulting occurs between the two, but at each place the horizon underlies a sandstone.

(*c*) *Beyrichoceras mutabile* horizon. Immediately above a sandstone in the Fury River there is a considerable thickness of shale. The pyritised fauna at the base (F22) yielded *B.mutabile* (Phill.) in association with the following :—

Nucula aff. *luciniformis* Phill.
Glabrocingulum sp.
Trepospira sp.
Nomismoceras spp.
Striatoid goniatite.
Thrincoceras sp.

Six specimens in the Geological Survey Collection, London, (Numbers 53567–72) from the Fury River, Co. Tyrone, Ireland, are referred to *B.mutabile* (Phill.) by Bisat (1934, p. 287). Another specimen (Number 53557), identified as *Nomismoceras* aff. *vittigerum*, is figured by Bisat (*op. cit.*, plate 20, fig. 3). The latter is pyritised, and may have come from the *B.mutabile* horizon. In a further outcrop some distance downstream (F17) a steeply dipping exposure of shale yielded a pyritised specimen of *Beyrichoceras* cf. *micronotum* (Phill.), indicating a horizon close to *B.mutabile*.

At this point mention may be made of a number of isolated exposures of calcareous shales which outcrop in the area. Four of them yielded goniatite fragments with a striatoid type of ornament, but in no case could the species be determined. The associated fauna and the lithological appearance of the beds, however, suggest a horizon towards the top of the *Beyrichoceras* zone. Details of the fauna are given below :—

Rotiphyllum sp. 52.
Chonetid 51b.
Nucula sp. 52, 53.
Palaeoneilo laevirostris (Portlock) 52.
Posidonia sp. 52.
Bucaniopsis hibernicum Weir 52, 53, 51b, F15.
Glabrocingulum sp. 52.
G. aff. *beggi* E. G. Thomas. 51b.
Discitoceras? cf. *crassum* (Foord) F15.
D? *sulcatum* (J. de C. Sow.) 53.
Nomismoceras sp. 52.
Thrincoceras sp. 53, 51b.

Posidonia Zone, P_1.

(*d*) *Goniatites crenistria* horizon. A specimen of the *G.crenistria* species-group was found about 20–25 feet above the base of the shales in which *B.mutabile* occurs (F22). The identification was confirmed by Mr. W. S. Bisat, who is disposed to ally it with *G.dinckleyensis* Bisat. This species is taken to indicate the basal portion of the *Posidonia* zone (P_1). The only other fossil associated with the above is a new species of *Thrincoceras*.

(*e*) *Beyrichoceras furyensis* horizon. Towards the top of the shales from which *B.mutabile* and *G.dinckleyensis* were collected, *Beyrichoceras furyensis*, sp. nov. M.S., occurs in some abundance through 30 feet of shale from which the following were also obtained :—

Fasciculophyllum omaliusi (Ed. & H.).
Koninckophyllum sp.
Lithostrotion pauciradiale (M'Coy).

L. sp.
Chonetes sp.
Dictyoclostus aff. *pinguis* (Muir-Wood).
D. sp.
Gigantoproductus sp.
G. cf. *maximus* (M'Coy).
Spirifer bisulcatus J. Sow.
Aviculopecten interstitialis (Phill.).
Nucula luciniformis Phill.
N. sp.
Nuculopsis gibbosus (Flem.).

Most of the corals and brachiopods were obtained from hard grey limestone lenses, with individual thicknesses up to 3 feet, embedded in the goniatite bearing shale. They appear to be original features of deposition.

The goniatite horizon is repeated by a fault a short distance downstream in the Fury River (F20), where *B.furyensis* again occurs abundantly. Specimens were collected from dark shales and also from iron-stone nodules in the shale. The following were also identified :—

Sphenopteridium pachyrrachis Göppert.
Nucula aff. *undulata* Phill.
N. sp.
Palaeoneilo laevirostris (Portlock).
Bucaniopsis hibernicus Weir.
Euphemites urei (Flem.).
Glabrocingulum aff. *armstrongi* E. G. Thomas.
Orthocone Nautiloids.

Outside the Fury River section the horizon was found at only one place (50b), where a few specimens of *B.furyensis* were collected from a limestone band in some calcareous shales, together with *Cyathaxonia* sp., *Lingula mytiloides* J. Sow. and a number of small Zaphrentids including *Zaphrentites delanouei* (Ed. and H.).

One further exposure in the Fury River remains to be mentioned (F16) since it contains abundant lamellibranchs, gastropods, and small brachiopods, similar to those listed above, with *Cryptophyllum* sp. and *Eomarginifera* aff. *lobatus* in addition. No trace of a goniatite was found apart from a small immature specimen which may be a young *Beyrichoceras*. Even in the absence of diagnostic goniatite material, there is nothing to suggest that the shales belong to any horizon outside the B_2P_1 range.

No goniatite horizons higher than the *B.furyensis* horizon have been discovered in the area, and there is every indication from the lithology of the overlying beds of an environment unsuitable for a marine fauna. In the Fury River, for example, about 100 feet of tough, calcareous siltstone and sandstone, interbedded with micaceous shales, follow the *B.furyensis* horizon before exposures cease. Generally the siltstone is even-bedded, but sometimes it occurs as concretionary masses in the shale. These are ovoid bodies up to 2 feet in height, embedded in silty micaceous shales which are warped around them. They appear to be post-depositional features resulting from redistribution of carbonate from lime-rich beds above and below. No fossils were found, though traces of carbonaceous material are sometimes seen.

Similar beds characterize the upper unfossiliferous part of the Yoredale Beds away from the Fury River. Bedding planes in the sandstones and siltstones often show ripple marks and worm casts, while at one place small scale ' slump ' features within the limits of a single bed were seen.

In the absence of fossils the zone to which the unfossiliferous beds belong cannot be determined. Since, however, they follow the fossiliferous beds conformably it is suggested that they belong to a later period of the *Posidonia* zone.

(*vi*) *Millstone Grit.*

The youngest beds present in the area may be conveniently referred to as the Millstone Grit. They are typically coarse sandstones and grits with lenses of pebbly material. Petrographically, they contain a very high proportion of quartzose material.

The base of the Millstone Grit cannot be seen in the Fury River section but it is well exposed to the west on the north-facing slopes of Slieve Beagh. Here the change from the Yoredale type of lithology is abrupt, and the massive bedded grits and coarse sands form a discontinuous topographical feature.

Within the Millstone Grit itself a distinctive intra-formational conglomerate is present. It is found at Ashban, Anketell, and Cross Glen, and consists of fragments of limestone and pebbly quartzose material up to 6 inches in length. The limestone fragments yielded a few corallites of *Lithostrotion* similar to those of the Upper Limestone. The evidence suggests that the conglomerate was laid down as a result of the elevation and erosion of Upper Limestone during Grit deposition.

The Millstone Grit is poorly fossiliferous, but a good internal mould of an undescribed species of *Productus* (*Gigantoproductus*) was collected. It appears likely that this specimen and also the *Lithostrotion* from the conglomerate are remanié in origin and are, therefore, valueless for dating the Grit. Without more suitable faunal evidence the geological age of the Grit cannot be determined.

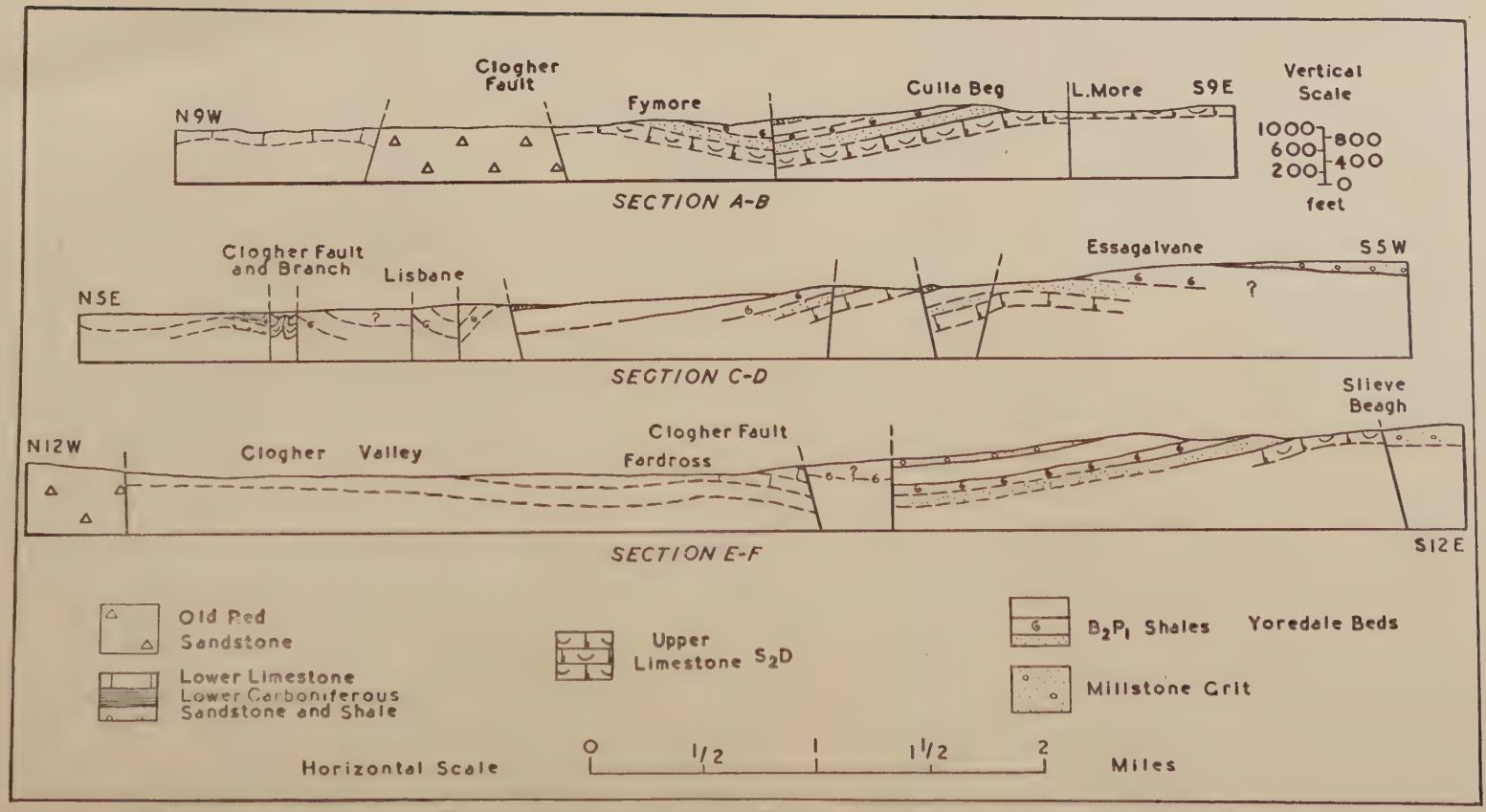

FIG. 3.—*Vertical sections across the Clogher–Slieve Beagh Area. The lines of Section are indicated on the map of the area* (fig. 4)
Note: In Section C-D the limestone underneath Essagalvane should be the Upper Limestone.

3. STRUCTURE.

The most important single structural feature is the fault which trends N 55°E and S 55°W near Clogher. This is shown on Geological Survey map (Sheet 46) to have associated branches, and its importance is commented upon in the accompanying Memoir (1886, pp. 18–19). The present examination has proved this mapping to be largely correct: the minimum throw of the fault, here named the Clogher Fault, is estimated at 300 feet but may be much more.

The evidence for this disturbance includes the marked discordance of the beds along its length and the increased dip which is shown as the fault is approached. Further evidence is provided by the Crocknanore quarry (F2′), where massive limestones have a brecciated appearance and are intricately veined with calcite. At Slatmore, to the south-west, limestones in a highly disturbed condition are exposed so that the bedding planes are no longer traceable. The whole mass is also irregularly veined with calcite. Again, the Fury River to the east-south-east of Clogher reveals Mid-Viséan limestone, wedged between the Clogher Fault and a branch of it, and thrown into sharp anticlines and synclines. Finally, the Calp Sandstone and Mid-Viséan limestone exposed south of Fardross are almost vertical for a distance of over $\frac{1}{4}$ mile.

The Clogher Fault separates two areas which are distinct in structure as well as in stratigraphy. To the north-west, exposures are rare owing to the thick cover of drift and alluvium, but there is no indication that the beds are other than gently folded. Two shallow folds are mapped at Fardross and near Belelastera Bridge. In each area the axes are roughly aligned with the Clogher Fault. The ground to the south-east, i.e. the downthrow side, differs not only in the existence of younger beds but in the severer tectonic disturbance. Numerous other faults, which are not shown on the Survey map, have become apparent after careful mapping of the lithological horizons supported by palaeontological evidence (See map, fig. 4). They seem to form part of a fault zone with the long major faults intersected by shorter cross faults, similar in pattern to that affecting the Carboniferous strata of the Coal Island—Dungannon region. The age of the faulting cannot be determined with certainty but probably dates from the late Carboniferous or early Permian when the Armorican orogeny was at a maximum.

In spite of the extensive faulting, a synclinal arrangement of the beds is apparent (fig. 3), particularly east of the Fury River: thus the Upper (Mid-Viséan) Limestone at Lough More emerges further north again at Fymore. In between, the Millstone Grit lies along the axis of the fold and continues south-westwards across the Fury River. The underlying beds, however, tend to be cut out to the north-west by the Clogher Fault, but isolated wedges of Upper (Mid-Viséan) Limestone remain at Slatmore and south-east of Fardross.

In the Geological Survey Memoir (Cruise, 1887) this synclinal arrangement is not stressed, while on the accompanying map (Sheet 46) Millstone Grit is limited

to a small area capping Slieve Beagh, and its presence along the axis of the fold goes unrecognized. The new evidence suggests that the synclinal structure is a direct consequence of the downthrow of the beds on the south-east side of the Clogher Fault.

4. Igneous Rocks.

The only rocks of igneous origin in the area are a few dolerite dykes. Some of these were mapped by the Survey in the Fury River, but additional ones have been found on the north slope of Slieve Beagh and in a stream at the extreme east of the area. They vary in width from 2 feet to 12 feet.

The main constituents are reddish brown augite crystals and laths of plagioclase feldspar with an andesine-labradorite composition. Magnetite is common throughout. Olivine is important in one of the newly discovered dykes on Slieve Beagh ; and in another ' serpentinisation ' of olivine to a mat of pale green antigorite crystals is observed in thin section. Occasionally amygdales up to $\frac{1}{4}$ inch in diameter occur along the margins of the dykes. The effect on strata is limited to an upwarping close to the intrusions, otherwise there is little or no metamorphism apart from a slight induration of the shales.

The dykes have general north-west to south-east alignment. This and their petrographical character suggest they belong to the Tertiary phase of igneous activity which affected the country between the Mourne Mountains and Donegal.

5. Fossil Localities.

? *Lower Viséan*, $?C_2S_1$.

F9. In Fury River, 110 yds. at 110° from Belelastera Bridge (59.S.W.).
F.D.4. Stream, 660 yds. at 173° from Fardross Bridge (64.N.E.).
F.D.5. ' Shell Bed ' in stream, 678 yds. at 175° from Fardross (64.N.E.).

Mid-Viséan Limestones, S_2D.

9. ' Kilruddan Rock ', 495 yds. at 325° from centre of Dunroe L. (65.N.W.).
11. Quarry near stream, 1,907 yds. at 157° from Fardross Bridge (64.N.E.).
13. Quarry, 1,325 yds. at 223° from Favor Royal Bridge (59.S.E.).
33x & 34. Cliffs along stream, 1,687 yds. at 161° from Fardross Bridge (54.N.E.).
39. Stream below road bridge, 1,833 yds. at 160° from Fardross Bridge (64.N.E.).
46. Outcrop, 2,728 yds. at 216° from Fardross Bridge (64.N.E.).
F2′. The Crocknanore Quarry, 495 yds. at 144° from Belelastera Bridge (59.S.W.).

F2″. Entrance to Crocknanore quarry, 495 yds. at 144° from Belelastera Bridge (59.S.W.).
F14. In Fury River, 440 yds. at 160° from Belelastera Bridge (59.S.W.).
33. In cliff beside farm, 1,870 yds. at 223° from Favor Royal Bridge (59.S.E.).
70. In Fury River, 1,723 yds. at 215° from Culla More summit (65.S.W.).

Yoredale Beds, B_2P_1.

47. In stream, 3,593 yds. at 211° from Fardross Bridge (64.S.E.).
48. McGregor's Hill, stream on west side, 1,283 yds. at 40° from Brackenridge's Tower (65.N.W.).
50b. Greaghnalurgana. In stream, 1,283 yds. at 166° from Brackenridge's Tower (65.S.W.).
51. In small stream, 2,640 yds. at 23° from Slieve Beagh summit (65.S.W.).
52. Greaghnasunna. In stream, 2,883 yds. at 220° from Culla More summit (65.S.W.).
53. In stream, 2,053 yds. at 305° from Slieve Beagh summit (64.S.E.).
F15. In right bank of Fury River, 687 yds. at 147° from Belelastera Bridge (59.S.W.).
F16. In right bank of Fury River, 2,640 yds. at 280° from Dunroe L. (65.S.W.).
F17. In Fury River, 953 yds. at 253° from the centre of Dunroe L. (65.N.W.).
F20. In Fury River, 1,843 yds. at 294° from Culla More summit and close to spot height 415. (65.N.W.).
F20/F21. In Fury River, 1,888 yds. at 291° from Culla More summit (65.N.W.).
F22. In Fury River, 1,797 yds. at 283° from Culla More summit (65.N.W.).
F24. In Fury River, 1,613 yds. at 272° from Culla More summit (65.N.W.).

Millstone Grit.

58. On north slope of a gorge, 1,149 yds. at 260° from Brackenridge's Tower (64.N.E.).

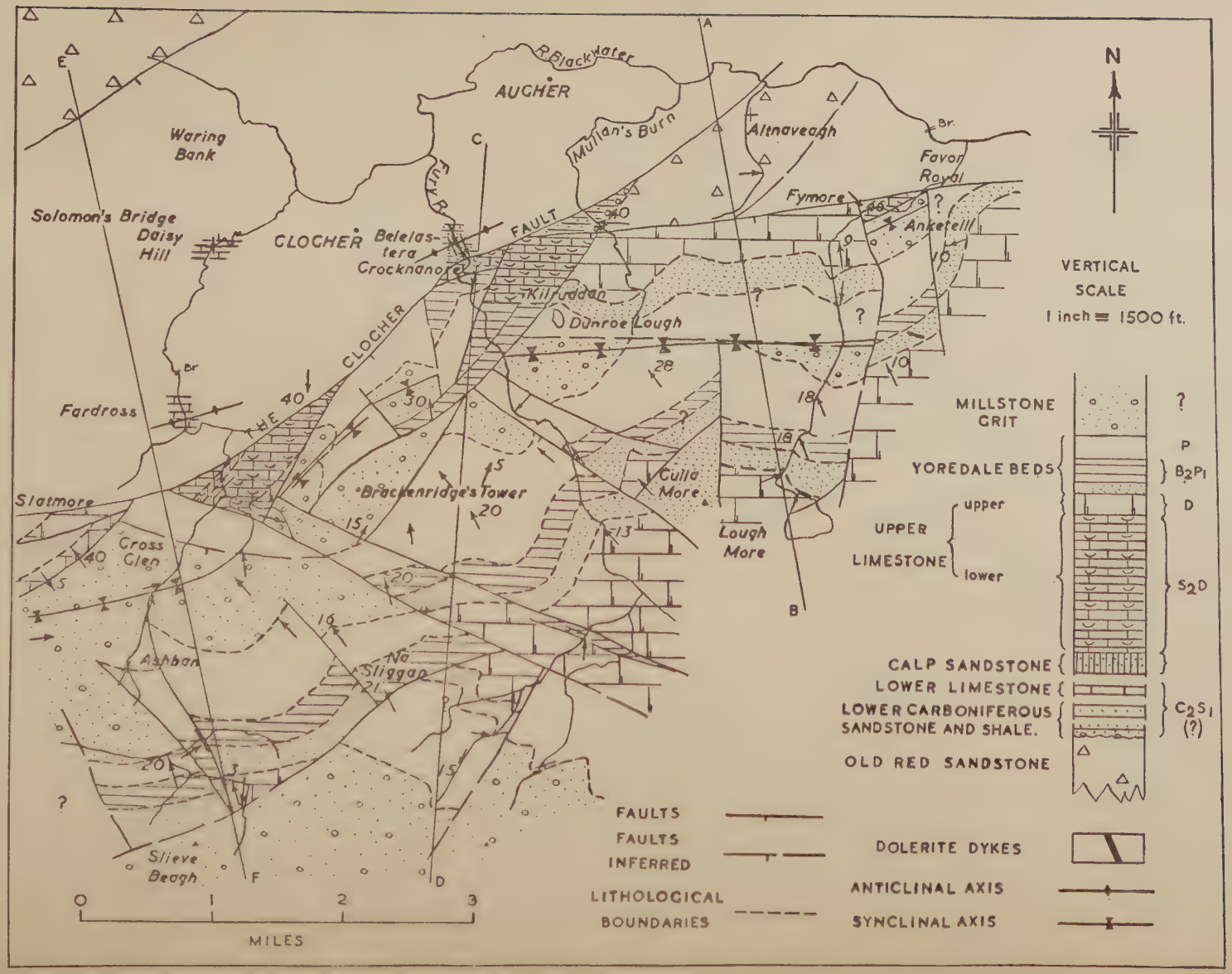

Fig. 4. *The Clogher–Slieve Beagh Area, County Tyrone.*

EXPLANATION OF MAP. FIG. 4.

Geological map of the Clogher–Slieve Beagh area. The Lower Carboniferous Sandstone and Shale and the Lower Limestone probably outcrop north-west of the Clogher Fault but owing to the paucity of exposures, detailed mapping is impracticable. This part of the area is, therefore, left largely unshaded on the map. The lines A–B, C–D and E–F indicate the lines along which the vertical sections in text-figure 3 are drawn.

Owing to reduction in reproduction the vertical scale of the section is about 1 inch to 1,800 feet.

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